



US009362530B2

(12) **United States Patent**  
**Visser et al.**

(10) **Patent No.:** **US 9,362,530 B2**  
(45) **Date of Patent:** **\*Jun. 7, 2016**

(54) **ENCAPSULATED WHITE OLEDs HAVING  
ENHANCED OPTICAL OUTPUT**

51/5234; H01L 51/5256; H01L 2551/301;  
H01L 2551/5361; H01L 2551/558

See application file for complete search history.

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(56) **References Cited**

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(\*) Notice: Subject to any disclaimer, the term of this  
patent is extended or adjusted under 35  
U.S.C. 154(b) by 0 days.

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This patent is subject to a terminal dis-  
claimer.

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(21) Appl. No.: **14/797,260**

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(22) Filed: **Jul. 13, 2015**

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(65) **Prior Publication Data**

US 2016/0013450 A1 Jan. 14, 2016

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**Related U.S. Application Data**

(63) Continuation of application No. 12/341,251, filed on  
Dec. 22, 2008, now Pat. No. 9,184,410.

(57) **ABSTRACT**

(51) **Int. Cl.**  
**H01L 51/52** (2006.01)  
**H01L 51/50** (2006.01)

Methods of making an integrated barrier stack and optical  
enhancement layer for protecting and improving the light out  
coupling of encapsulated white OLEDs are described. The  
method includes optimizing the thickness of various layers  
including one or more of the plasma protective layer, the  
initial organic layer, the initial inorganic barrier layer, and the  
inorganic barrier layer and polymeric decoupling layer for the  
barrier stack. The thickness is optimized for at least one of  
total efficiency, or intentional color point shift so that the  
encapsulated OLED has enhanced light outcoupling com-  
pared to the bare OLED.

(52) **U.S. Cl.**  
CPC ..... **H01L 51/5275** (2013.01); **H01L 51/5206**  
(2013.01); **H01L 51/5234** (2013.01); **H01L**  
**51/5237** (2013.01); **H01L 51/5256** (2013.01);  
**H01L 51/5262** (2013.01);  
(Continued)

(58) **Field of Classification Search**

CPC ..... H01L 51/5275; H01L 51/5206; H01L

**9 Claims, 10 Drawing Sheets**

